



Characterization of Potential Storage Sites in the West Coast States

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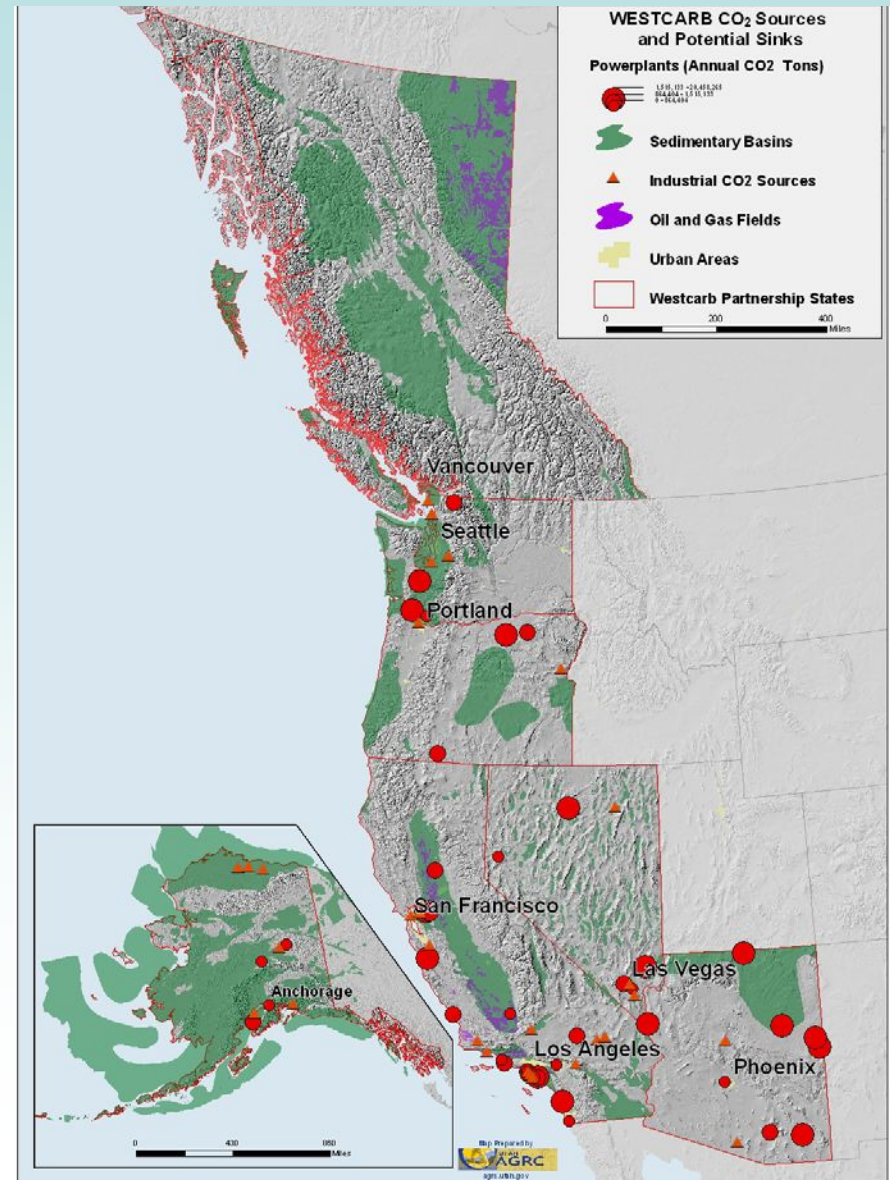


Steps in Assessing Storage Potential for WESTCARB Region

- Identify and characterize point sources
- Identify and characterize sedimentary basins
- Identify and characterize oil and gas fields and coal beds within sedimentary basins
- Screen basins – a preliminary screen based on depth, size, restricted surface access, lack of seals, yields subset for further analysis
- Estimate storage capacity
- Do GIS-based economic analysis of source-sink combinations

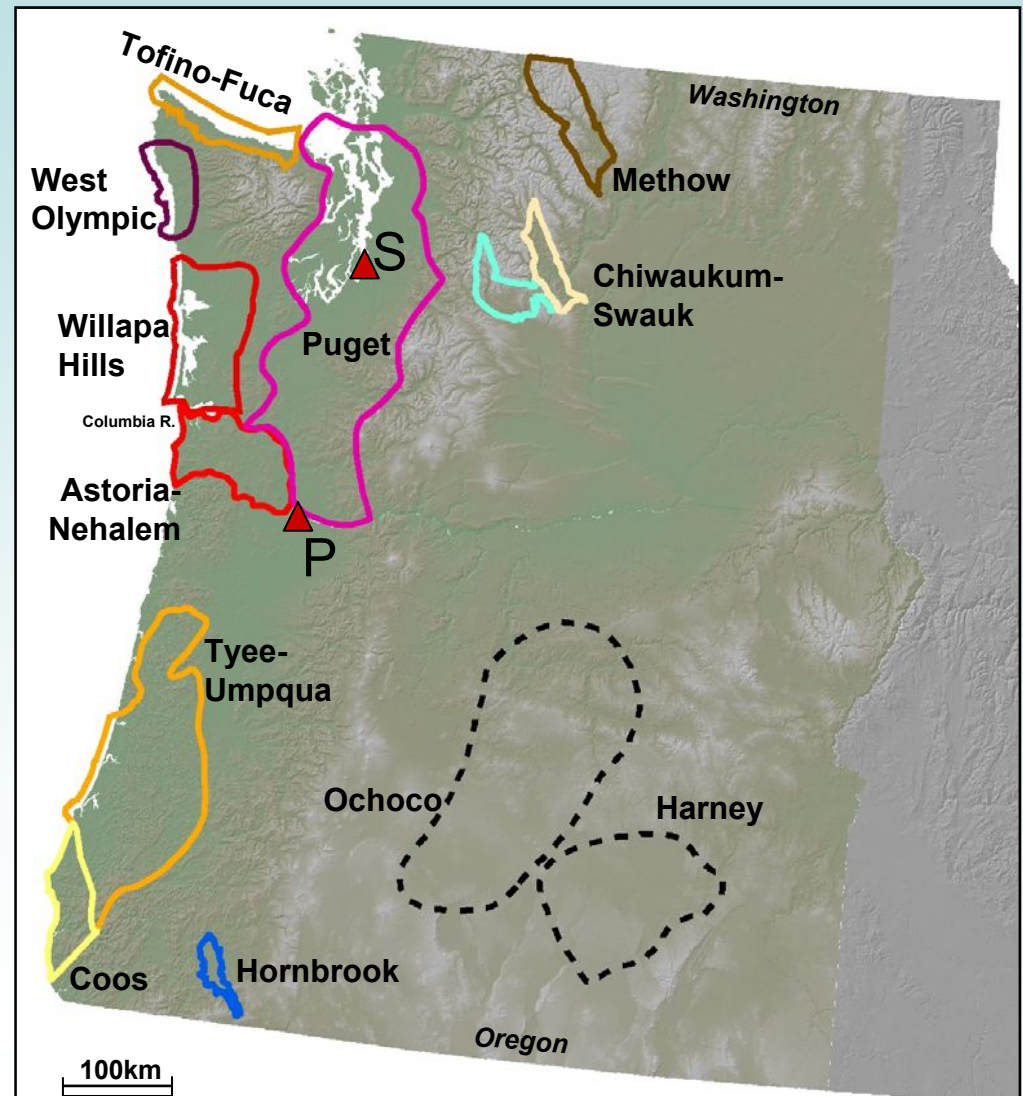
Sedimentary Basins Broadly Distributed

- Characterized sources account for about 80% of total industrial and utility sector emissions (US)
- Sedimentary basins defined; geologic and oil and gas field data assembled
- Data reside at Utah AGRC, publicly accessible, part of NATCARB database

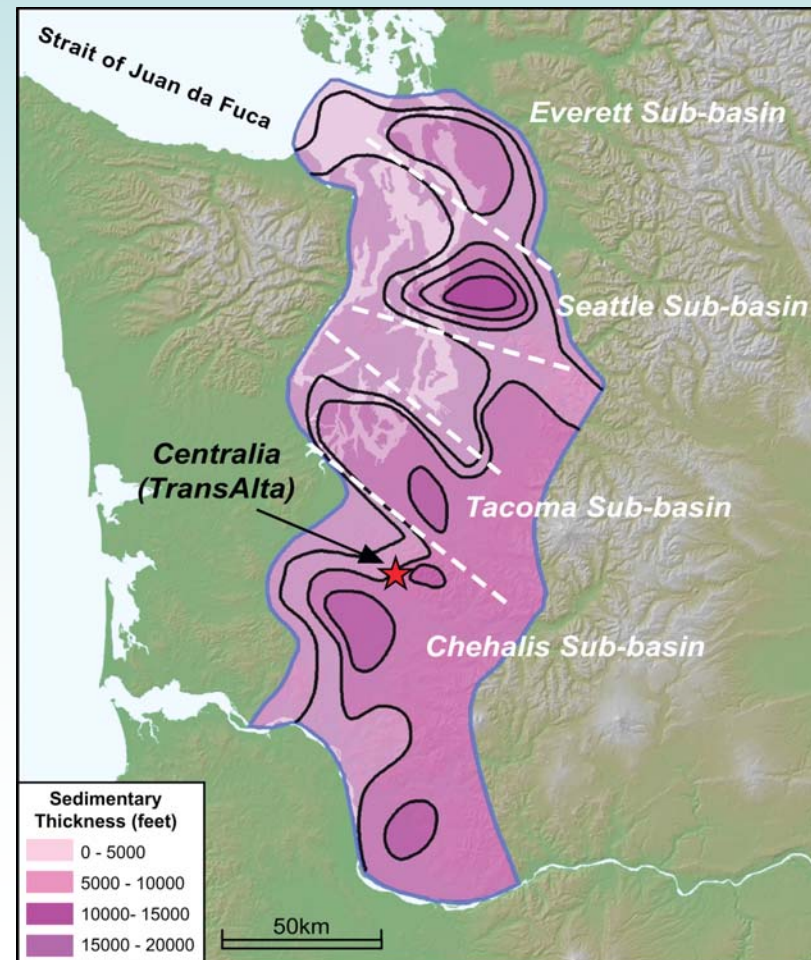
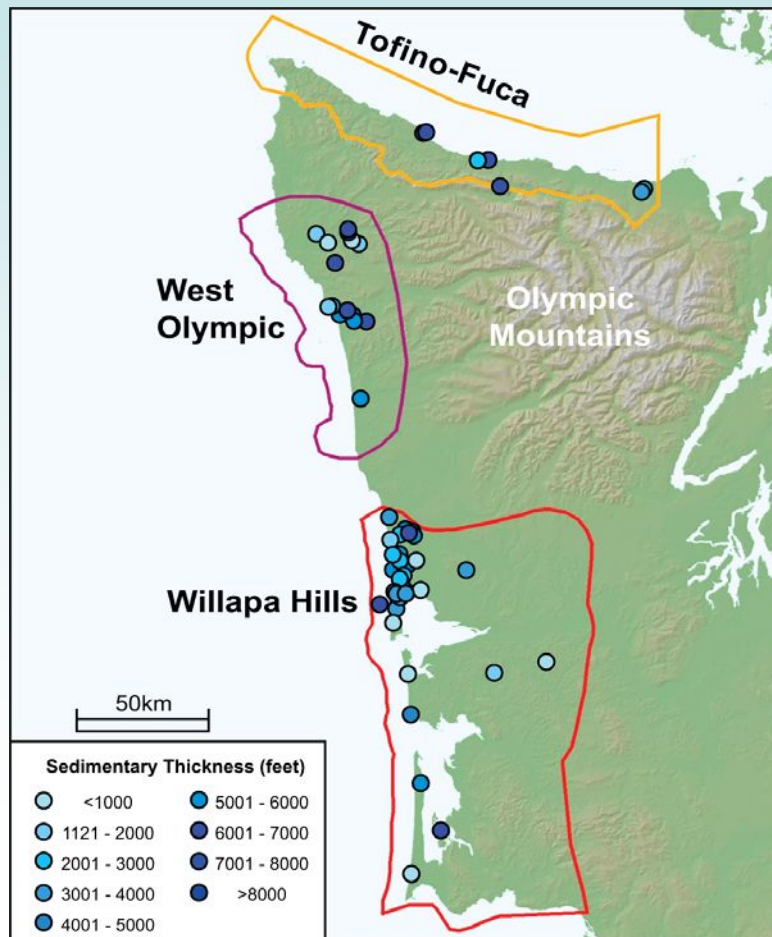


Sedimentary Basins in Oregon and Washington

- Major targets in Coastal Ranges and Puget-Willamette Lowlands provinces
- Several Interior basins
- 30+ unconsolidated basins

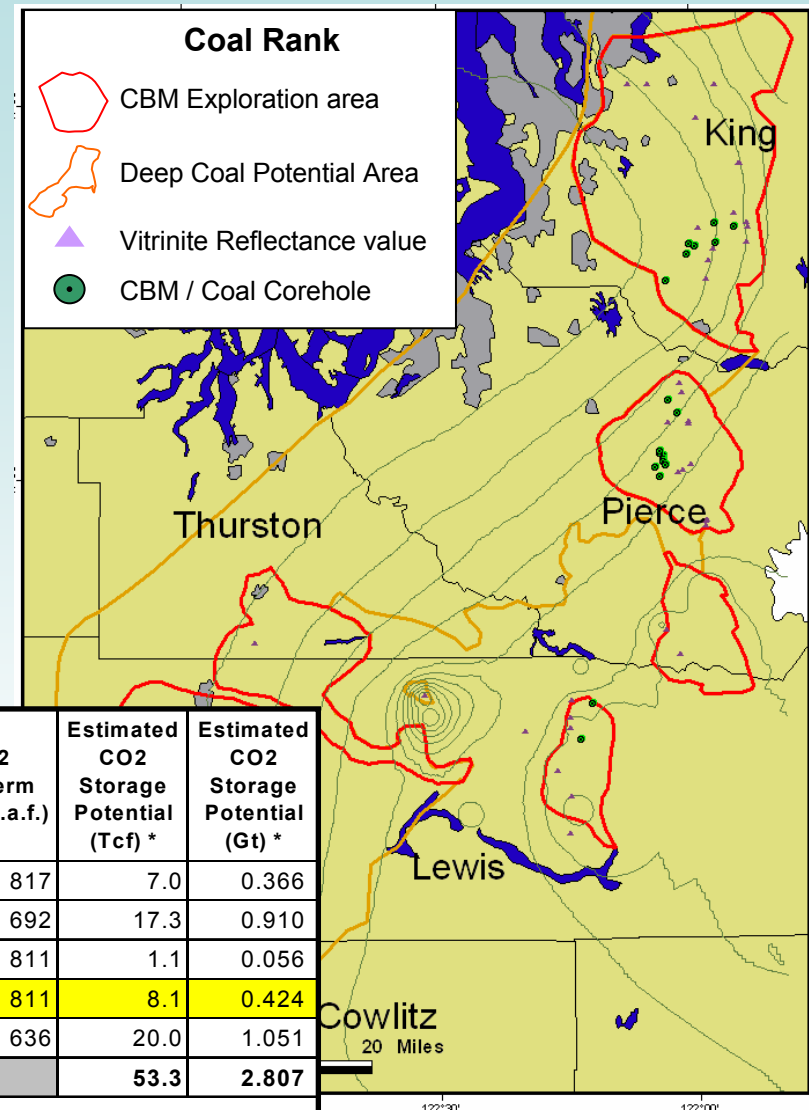


Tertiary Basins Contain Thick Sedimentary Sequences



Puget, WA Deep Coals Are a Potential Sink

- Favorable coal rank: sub-bituminous in the W to anthracite in E
- El Paso Production pilot tested 5 md permeability in coals

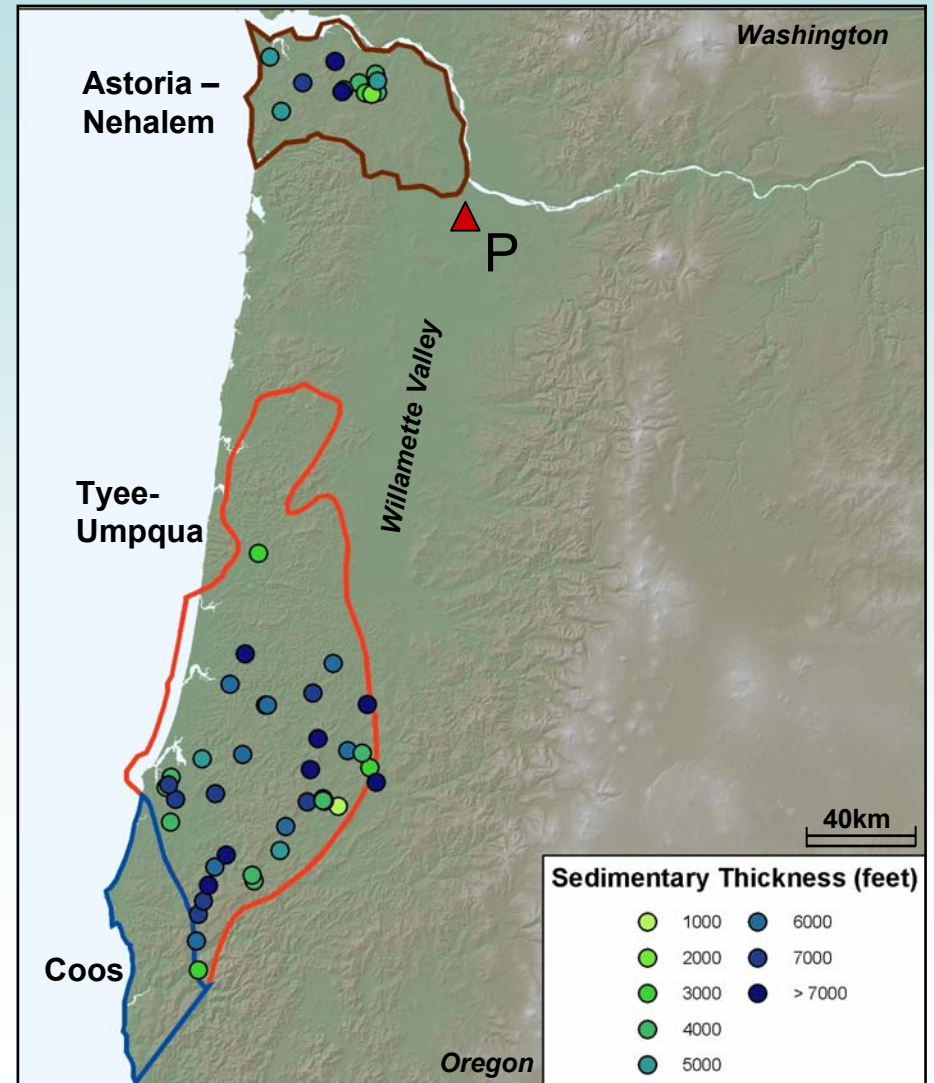


Sub-Basin	Area (sq mi)	Avg Coal Thickness (ft)	Ash + Moisture (%)	Net Coal Tonnage (million tonnes)	Avg Depth (ft)	CO2 Isotherm (scf/t d.a.f.)	Estimated CO2 Storage Potential (Tcf) *	Estimated CO2 Storage Potential (Gt) *
Carbonado	125	130	57%	8,513	1,691	817	7.0	0.366
Black Diamond	466	110	60%	24,979	1,550	692	17.3	0.910
Storm King	57	65	71%	1,309	1,860	811	1.1	0.056
Centralia	209	100	61%	9,930	1,860	811	8.1	0.424
Rest of Puget Region	1,777	50	71%	31,391	1,500	636	20.0	1.051
Totals	2,634			76,122			53.3	2.807

* Represents TOTAL available potential for each region; actual Stored volume would be significantly less (~15-50%)

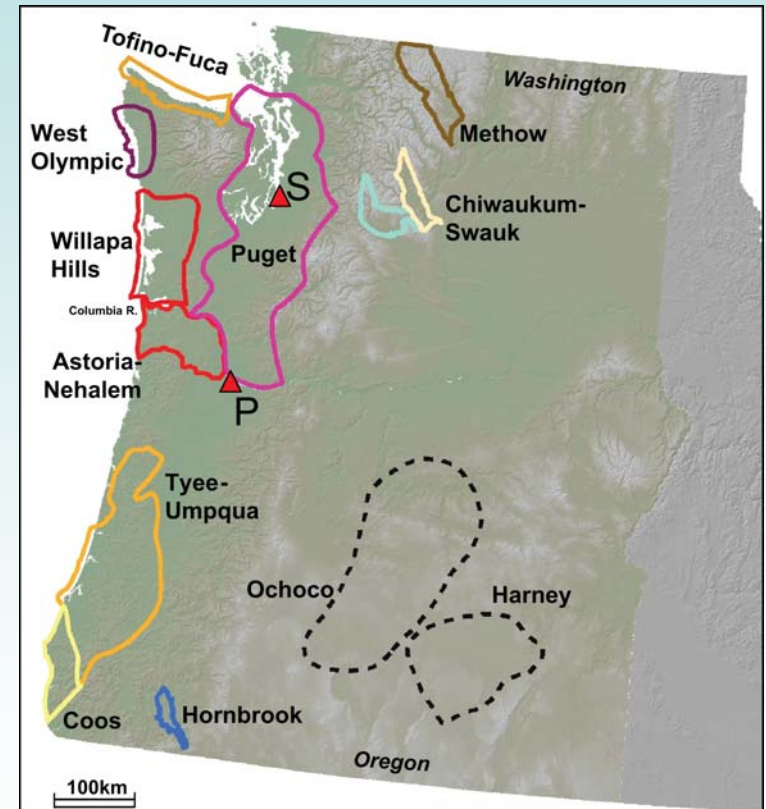
Coastal Range Basins of Oregon

- Astoria-Nehalem Basin
 - Extensively faulted/folded
 - Mist Gas Field (65 BCFG)
 - C&W Sands:
 - Porosities: up to 39%
 - Permeabilities: 1–1,400 md
- Tyee-Umpqua Basin
 - Massive Tyee sandstone
- Coos Basin
 - Marine sequence up to 10,000 ft thick



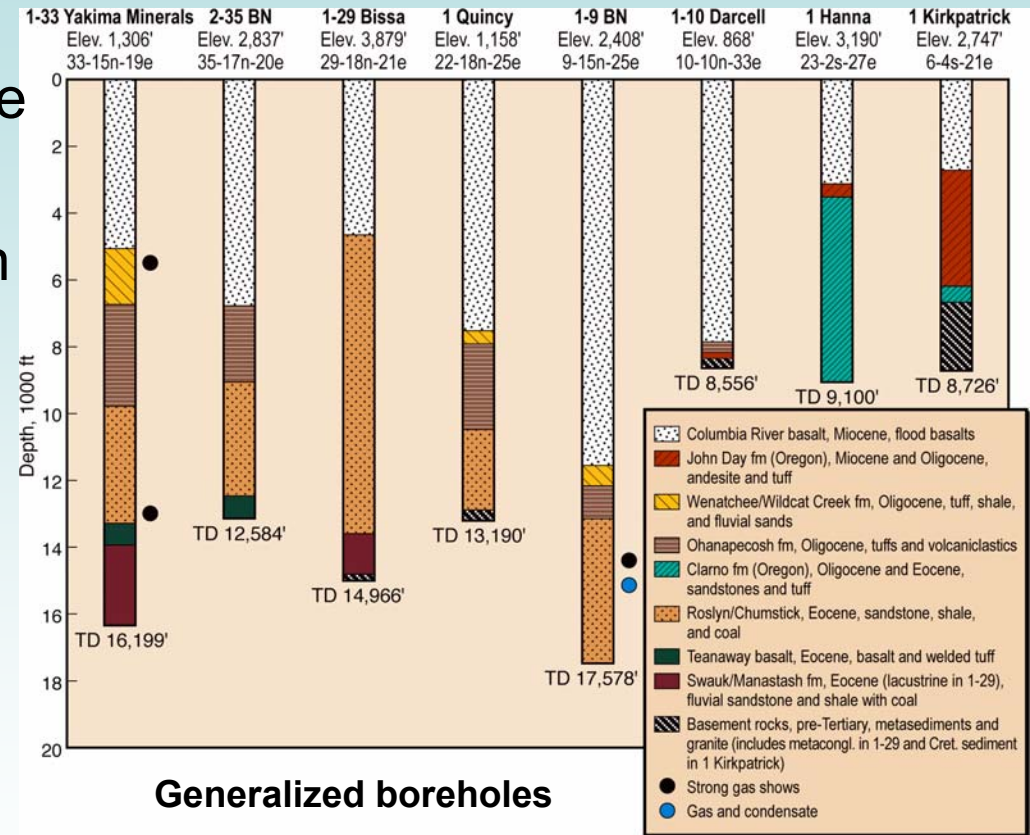
Interior Basins

- Methow Basin
 - ~13,000 feet of sediments
 - Several massive sandstones (Winthrop)
- Chiwaukum Basin
 - ~19,000 ft of continental sedimentary sequences
- Hornbrook Basin
 - ~4,000 feet sequence
 - Hornbrook Fmn. sandstones:
 - Porosities: 6.3-18.6%
 - Permeabilities: up to 1.2 md
- Ochoco Basin
 - >5,000 feet of fluvio-deltaic sandstones/conglomerates



Sub-Columbia Plateau

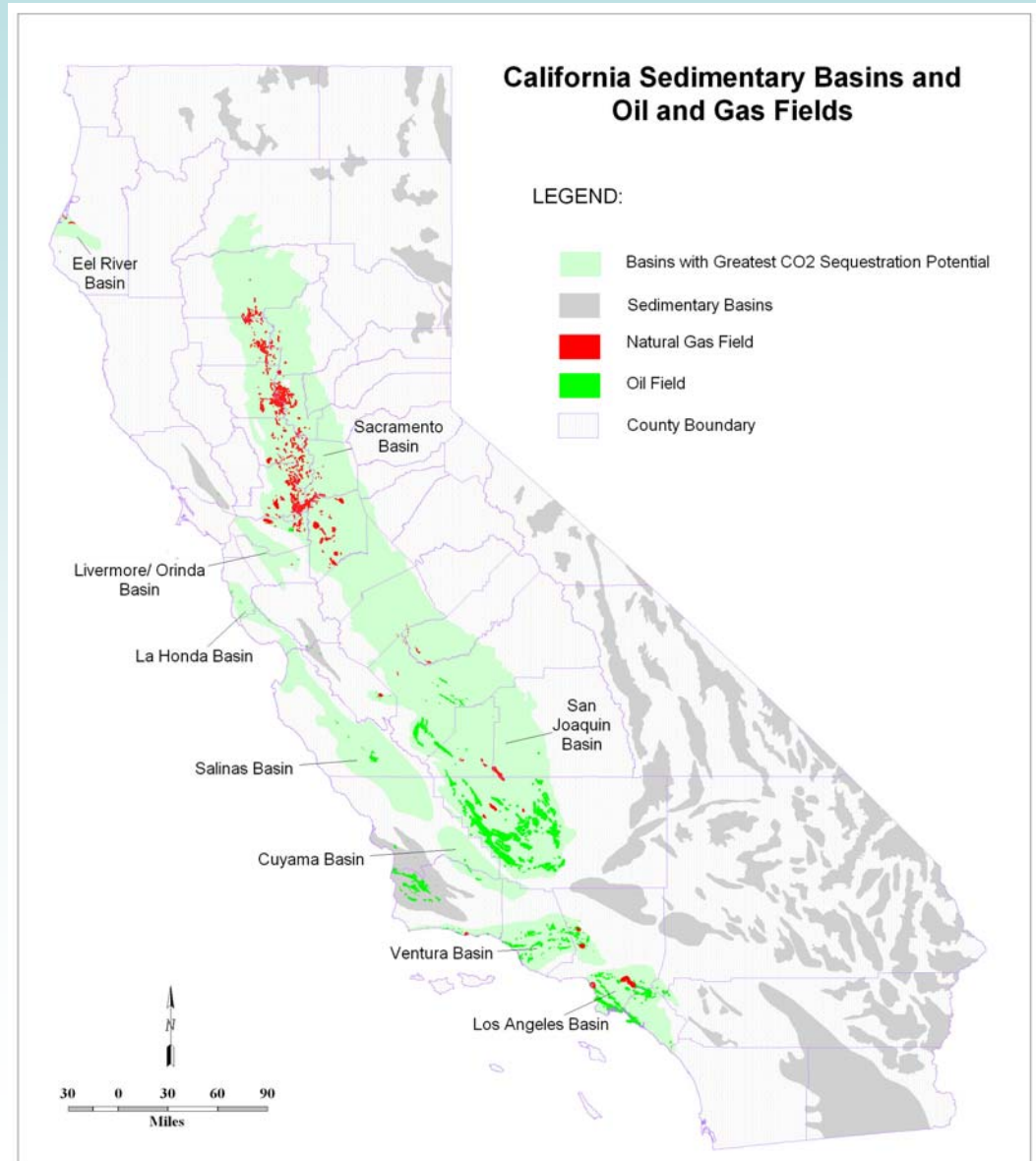
- Thick basalt flow sequence (up to 15,000 ft)
- Several deep investigation boreholes
 - Fluvial sandstones and conglomerates
 - Volcaniclastics, tuffs and shale interbeds
 - Sandstone properties:
 - Porosities: 4– 22%
 - No permeability data



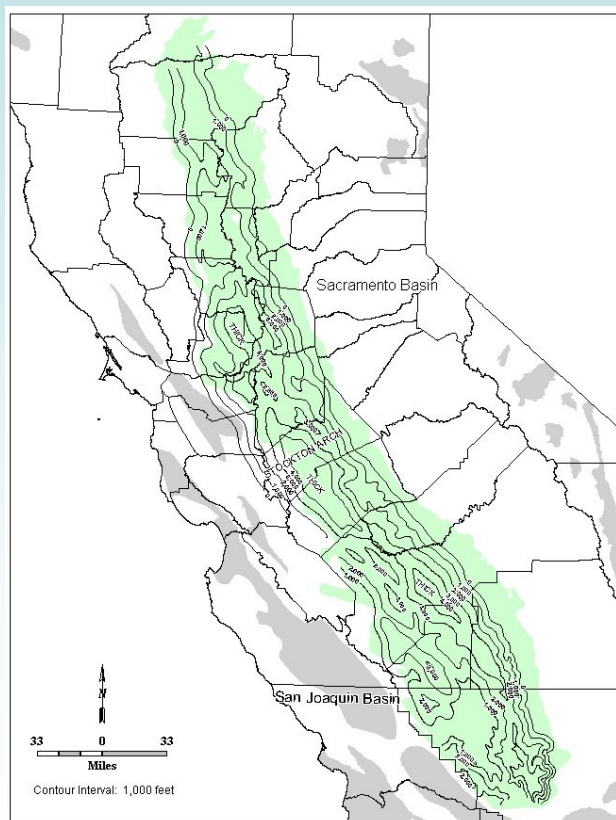
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Most Promising California Basins

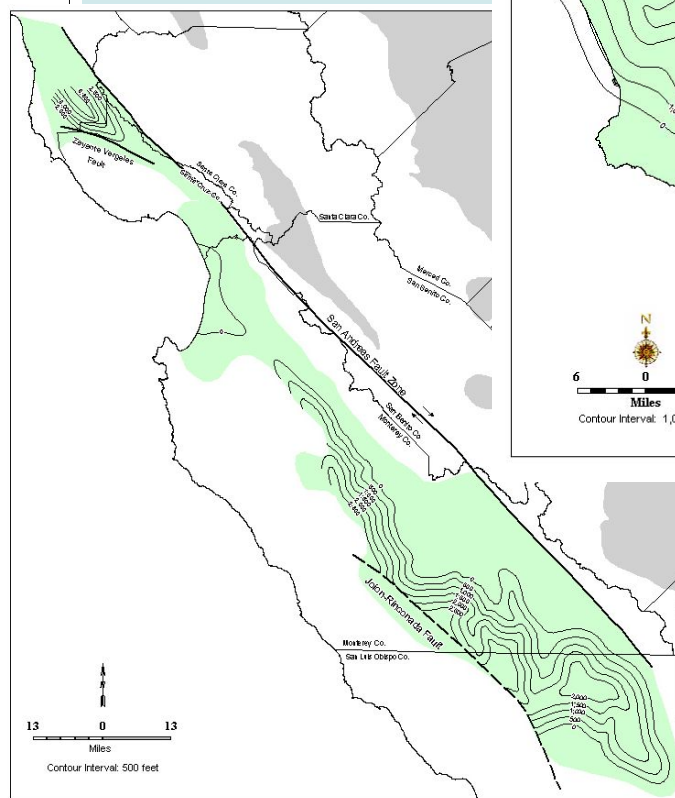
- Multiple porous, permeable targets
- Laterally persistent marine shale seals
- Oil, gas reservoirs; abundant data



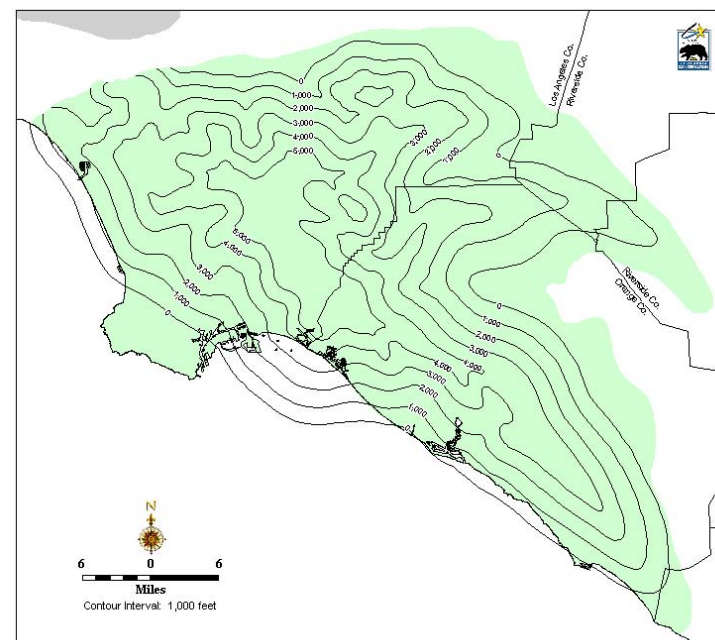
Basin-scale Sand Isopach Maps



Sacramento and
San Joaquin Basins

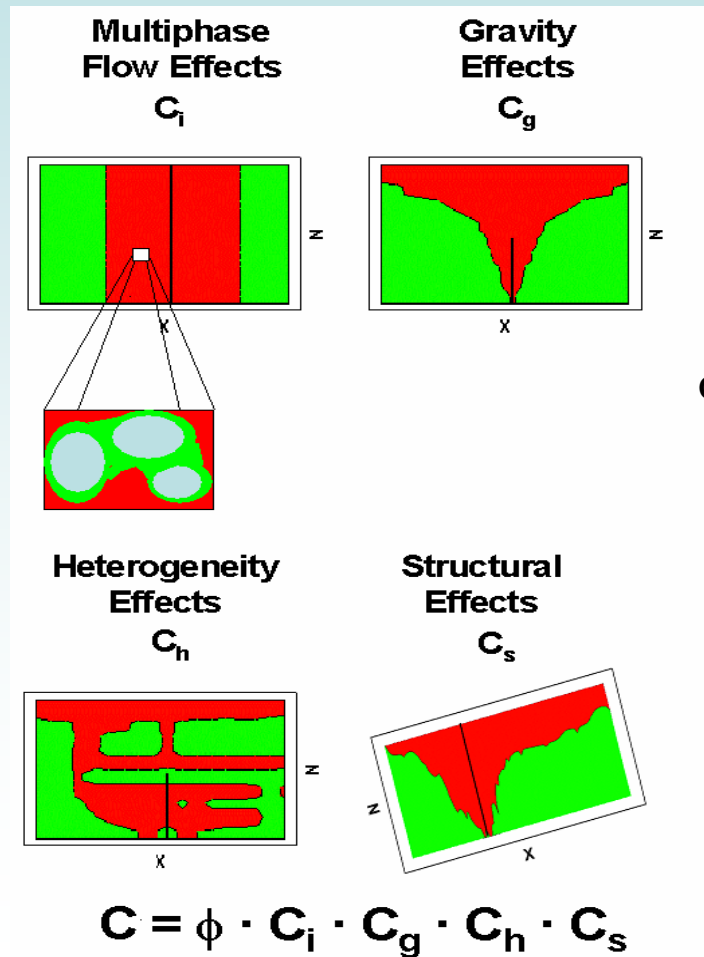


Salinas and La Honda Basins

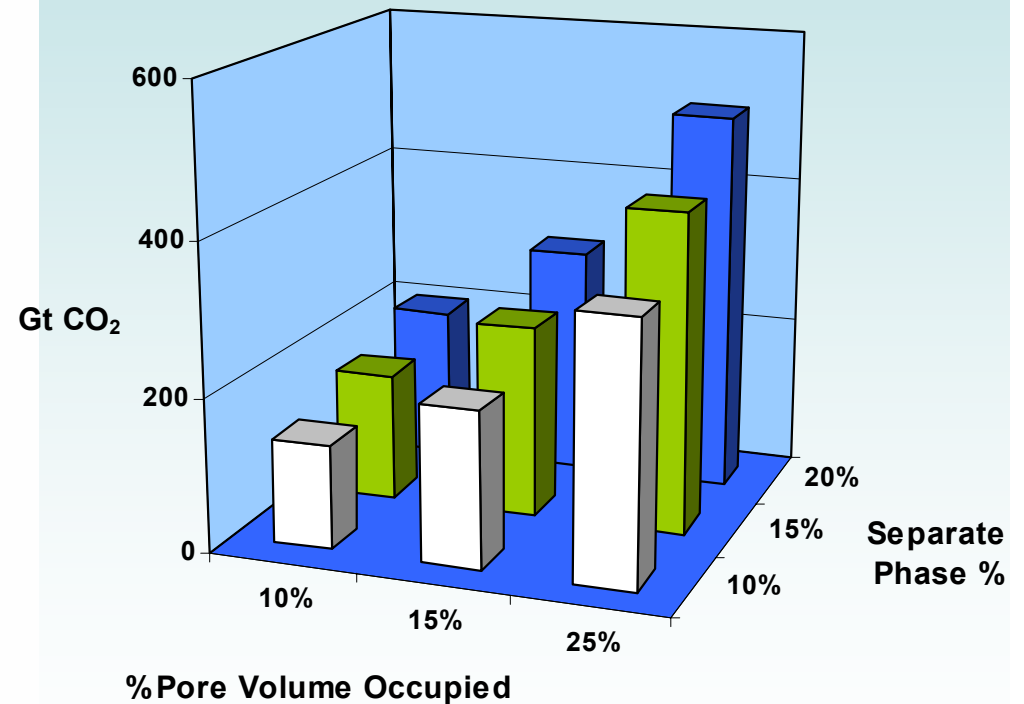


Los Angeles Basin

Many Factors Affect Capacity Calculations

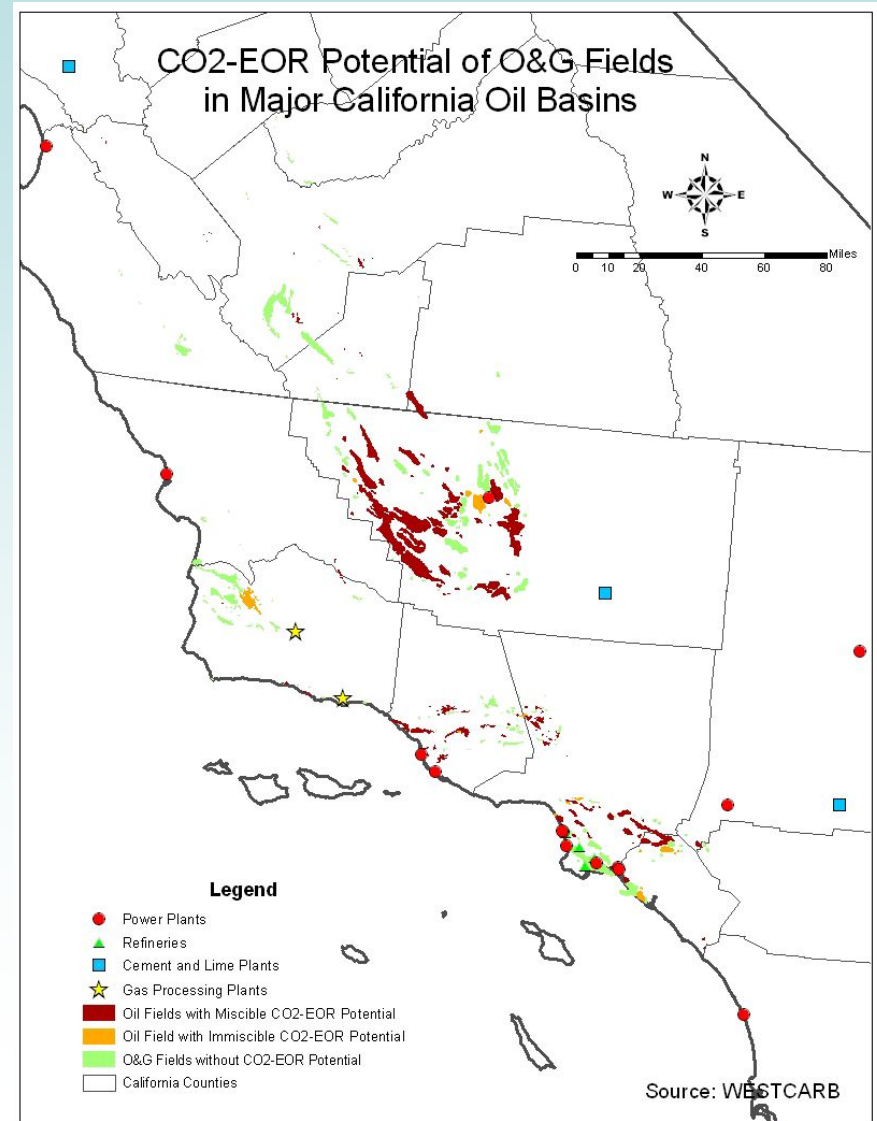


Range of Saline Formation Capacity

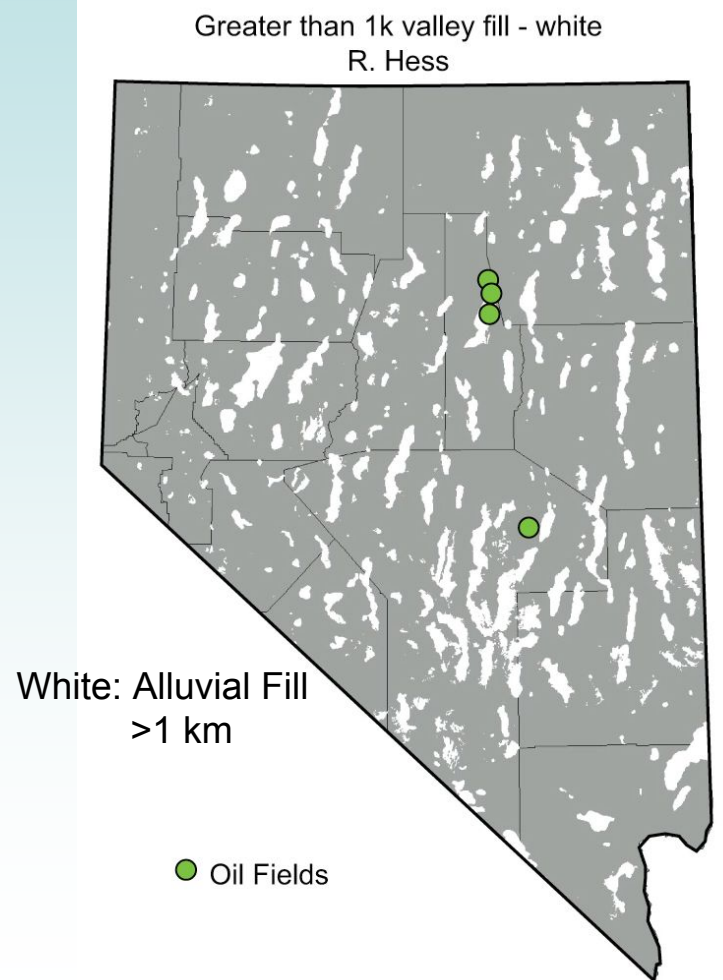
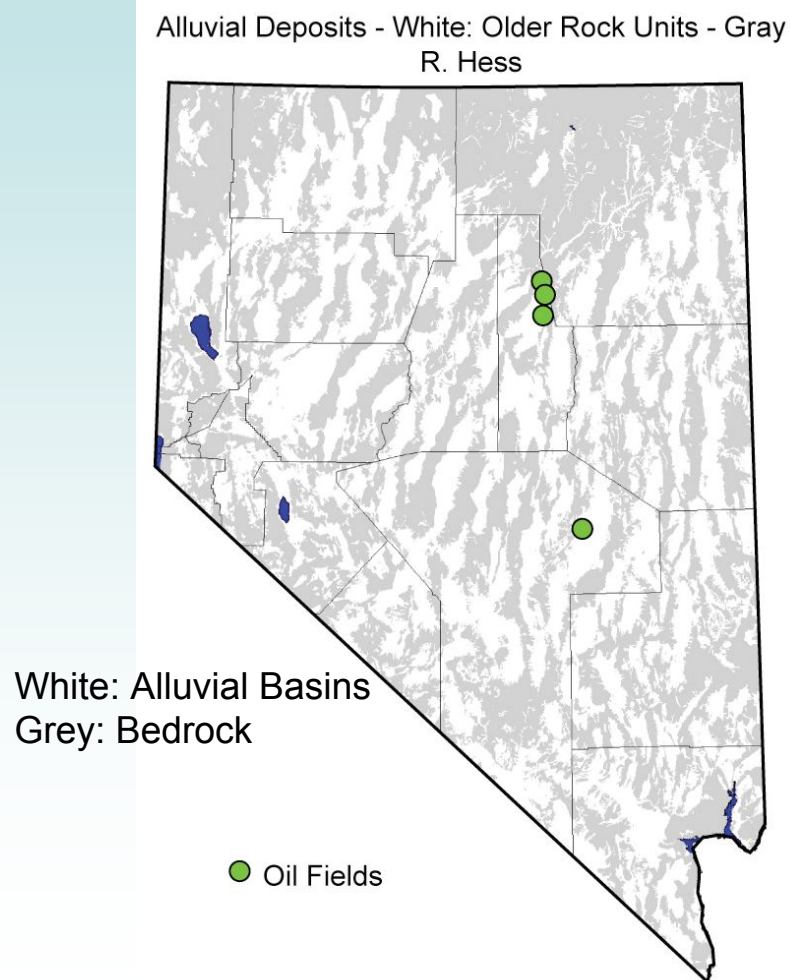


Significant Opportunities for EOR and EGR

- 121 fields met depth and miscible EOR criteria
 - 3.4 Gt CO₂ storage capacity, using production as a basis
 - Other studies suggest 5.4 billion barrels oil technically recoverable
- 128 gas fields met depth criteria
 - 1.8 Gt CO₂ storage capacity

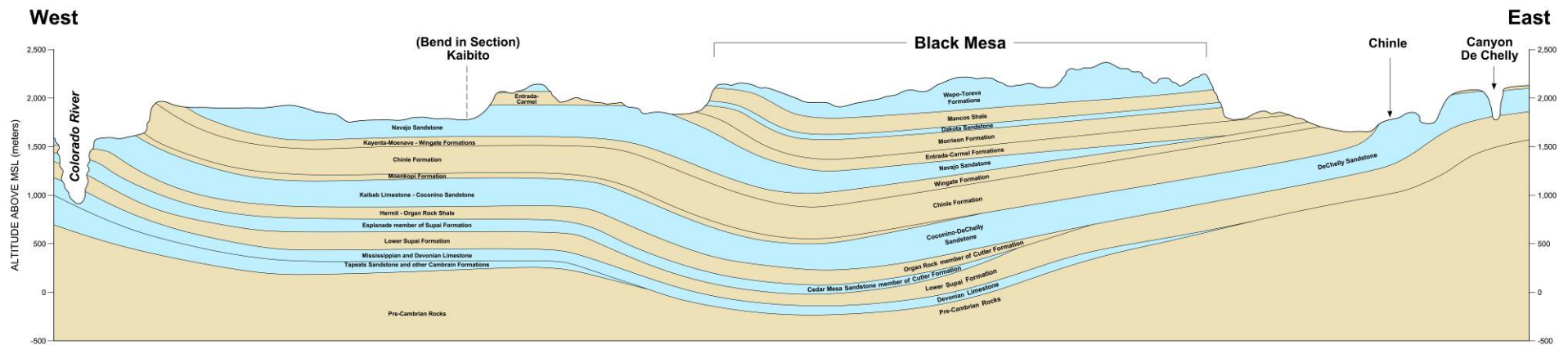
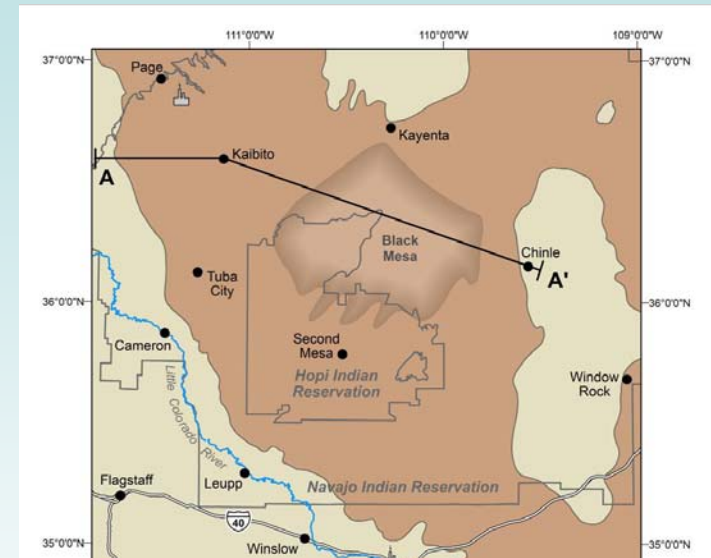


Alluvial Deposits in Basin and Range Offer Suitable Depth but Little Characterization Data



Colorado Plateau Is a Major Arizona Sink

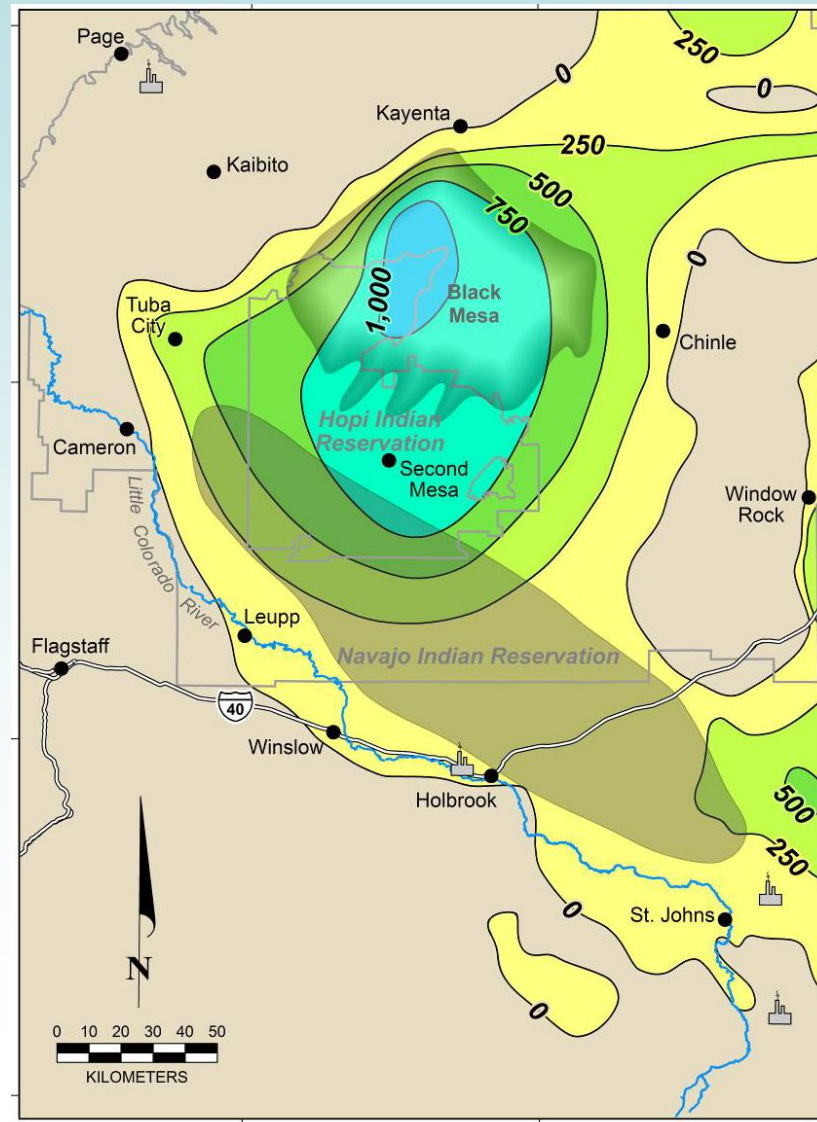
- Chinle is regional seal
- Potential reservoirs in Coconino, Supai, Tapeats



GEOLOGIC CROSS-SECTION FROM COLORADO RIVER, THROUGH BLACK MESA, TO CANYON DE CHELLY

Hydraulic Head and Salinity Data

Contours of hydraulic head overlain by area in which TDS is $>10,000$ mg per liter



Conclusions

- Sedimentary basins for potential CO₂ storage are broadly distributed in West Coast states
 - Multiple porous targets in many basins
 - Laterally extensive shale seals
- Storage capacity of California is a major potential resource
- Challenges: complex geology, lack of data in some areas
- Additional characterization underway